REFLECTIONS 1988-89

NATIONAL WATER RESEARCH INSTITUTE

HC "THE OLD MAN AND THE HUNTERS" MICHAEL HARRIS

FRONT COVER:

THE OLD MAN AND THE HUNTER

Copper etching by Canadian artist Michael Robinson. 1987.

ABOUT THE ARTIST:

Michael Robinson (b. 1948) lives in Keene, Ontario, and on Manitoulin Island, in northeastern Ontario, in the summer. Since 1970 his work has been shown in more than fifty galleries, studios and craft workshops in Canada and the United States. Robinson's drawings and poetry, placed throughout the text, portray his native culture and its bond to the earth. His work depicts the wonder of the earth and laments its destruction from the perspective of his people who, he says, are "trying to adjust from a very earth-related society into a technological society that has created itself as the centre."

PUBLICATION DISPONIBLE EN FRANÇAIS SUR DEMANDE

REFLECTIONS 1988-89

EXECUTIVE DIRECTOR'S REPORT
NATIONAL WATER RESEARCH INSTITUTE

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Our world is changing. Global warming, expanding deserts, shrinking forests, dying lakes and a thinning ozone layer are all mute testimony to that alteration. Furthermore, in many countries of the world, the need for economic development, the agent of much of this change, has never been more pressing. Many of the world's most populous countries are poised and eager for unprecedented economic growth. Our world is indeed changing.

Acceptance of that stark and simple truth has led communities and governments to realize that they must adapt or face decidedly unpleasant consequences. Old habits and old attitudes will not serve us well in this emerging world. Fortunately, we have an agenda for change that promises to help overcome the present difficulties.

First, we must clean up the global mess. Second, we must embrace the concept of sustainable economic development and find ways to grow that will not condemn the world's children to a life of poverty in a polluted wasteland. Third, we must act in concert with other nations to achieve environmental security, because global problems require worldwide solutions. Clearly, these goals are easier stated than achieved, but the stakes are too high to refuse the challenge.

As we face a future of change and uncertainty, science, especially environmental science, will be called upon as never before for answers, judgement and guidance. There isn't time for certainty. We must act now and with the benefit of today's scientific judgements. It is in times like these that the true value of a national resource like Environment Canada's National Water Research Institute becomes apparent. With its specialized expertise, understanding of Canadian ecosystems, and access to knowledgeable researchers around the world, scientists at the Institute are well positioned to help meet the challenges that lie ahead.

It is with pride and a certain degree of comfort that I preface the Institute's annual report—pride in being associated with the impressive achievements presented herein and comfort in the knowledge that such dedicated and accomplished scientists are allies in our struggle for environmental security.

Lucien Bouchard
Minister of the Environment

INTRODUCTION

To see a World in a Grain of Sand
—William Blake

What science knows about the world is constantly changing. The only certainty for science is that today's achievements will be superseded by tomorrow's. Scientists are therefore accustomed to change and have learned to value the emergent. In this sense, a planet that is undergoing rapid environmental change is exciting to a scientist; it is, in effect, a global scientific experiment. On the other hand, being part of the experiment has its drawbacks, and scientists, like everyone else, are uncomfortably aware of the irony in the old Chinese curse: "May you live in interesting times."

Today, what is most remarkable is the global scale of the environmental changes and problems that we face. We cannot act in isolation and control our own destiny. Worldwide collaboration and cooperation are more important than ever, both in environmental science and environmental policy-making. The pace of environmental change is also accelerating, so that scientists and decision-makers must collaborate more effectively to ensure that well-informed choices are made. These themes are reflected in the selection of highlights described in this report.

Environment Canada's National Water Research Institute (NWRI) conducts a national program of research and development in the aquatic sciences. In so doing, the Institute develops the knowledge and expertise needed to address the water-related environmental issues facing Canada. This report does not do justice to the diversity of work carried out by NWRI scientists, which in any case would be difficult in a few pages. Rather, it provides a selection of highlights representative of the Institute's work related to the themes of international participation, and the contribution of science to decision-making.

Artist Michael Robinson provided the art gracing the pages of this publication. His work draws on his native heritage and expresses a unique vision of life and of mankind's relationship to nature.

D.L. Egar
Burlington, Ontario
May 1989

THE CHANGING ATMOSPHERE

"Humanity is conducting an unintended, uncontrolled, globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war." That was the warning contained in the final statement issued by experts participating in the World Conference on the Changing Atmosphere, held in Toronto during June 1988.

The conference was organized by Environment Canada and supported by the United Nations Environment Programme and the World Meteorological Organization. Dr. R.J. Daley of NWRI co-organized the water program at the conference and drafted the final report of that session.

Key events leading up to the Toronto gathering were the publication of the World Commission Report on Our Common Future, the Montreal Ozone Protocol signed by two dozen countries in September 1987, and a policy statement on climate change issued by a gathering of policy experts and scientists in Bellagio, Italy.

Gro Harlem Brundtland, Prime Minister of Norway and Chair of the World Commission on Environment and Development, expressed the hope that "the theme of this conference...may finally open our eyes to the fundamental fact that the earth is one, even if the world of man is still divided."

Major factors identified as contributing to the deterioration of the atmosphere included air pollution, the burning of fossil fuels, deforestation, and the effects of rapid population growth. These activities are changing the atmosphere by enhancing the greenhouse effect, which could lead to climate warming, rising sea levels and changes in rainfall patterns. Such activities are also releasing chemicals that are depleting the earth's ozone layer and increasing the contamination of the atmosphere with toxic chemicals and pollutants found in acid rain.

Prime Minister Brian Mulroney, in his opening address to the conference, proposed the establishment of a comprehensive global agreement to protect the atmosphere, for discussion at the 1992 international conference on sustainable development. Urging quick global action he said: "This is not just about the atmosphere, it is not just about the environment, it is about the future of the planet itself."

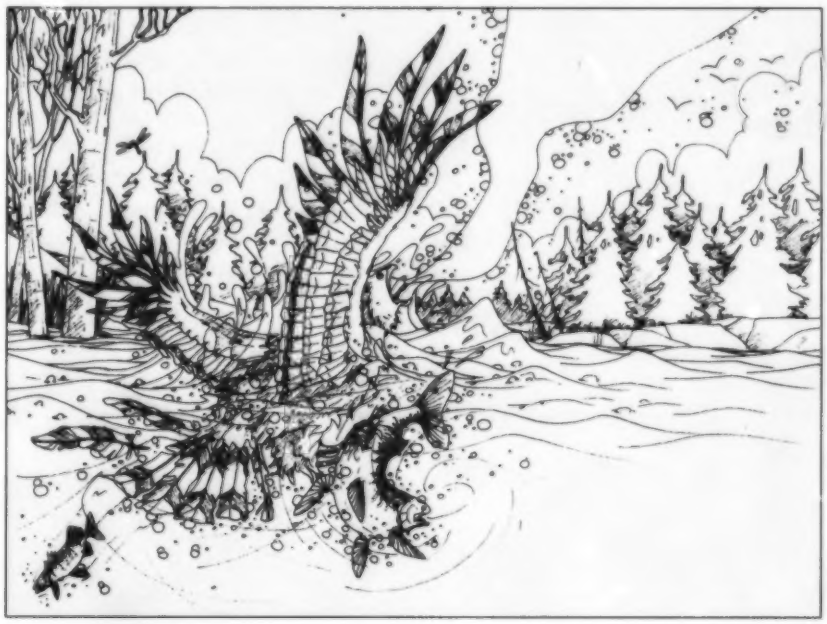
HIGHLIGHTS

NASA COMES TO HUDSON BAY

For six weeks during July and August of 1990, a NASA aircraft crammed with sophisticated scientific equipment will fly in a precisely determined pattern over the Hudson Bay Lowland. On board, scientists will measure the fluxes and concentrations of methane and other gases as part of NASA's Global Troposphere Experiment. It is also part of a joint Canada/U.S. initiative called the Northern Wetlands Project.

Methane is a "green house" gas contributing to global climate change. After remaining constant for more than 10 000 years, the concentration of methane in the earth's atmosphere has doubled since the nineteenth century and is currently increasing at the rate of 1% per year. The reasons for this worrying increase are poorly understood, but wetlands have been estimated to account for as much as 40% of methane formation. Canada is blessed with one of the largest wetland areas in the world in the Hudson Bay Lowland. This is why more than 30 scientists from three countries will spend the summer of 1990 there studying the exchange of gases between the wetlands and the air. A gas exchange model for wetland regions will be developed and used to estimate the net flux of gases escaping from the Hudson Bay Lowland to the atmosphere.

Dr. W. A. Glooschenko from NWRI has been appointed Project Coordinator of the Northern Wetlands Project. It is truly a multidisciplinary effort, involving scientists from five government agencies, seven Canadian universities, two companies, one U.S. university, and two German research institutes. This comprehensive study will also contribute to the International Geosphere-Biosphere Program aimed at understanding the phenomena of global change.



Cry of the Hunter

GLOBAL METAL POLLUTION

"Each year, millions of tonnes of 'new' trace metals are produced from the mines and subsequently redistributed in the biosphere. The annual total toxicity of all the metals mobilized, in fact, exceeds the combined total toxicity of all the radioactive and organic wastes generated each year, as measured by the quantity of water needed to dilute such wastes to drinking water standard." These statements are drawn from the conclusions of a paper published in *Nature* in May 1988. Dr. J.O. Nriagu of NWRI is the senior author of the paper.

Dr. Nriagu has published extensively on the behaviour of metals in the environment. In this paper, he and his co-author, Dr. J.M. Pacyna of the Norwegian Institute for Air Pollution Research, take a global perspective and attempt to provide a quantitative assessment of worldwide contamination of air, water and soils by trace metals. The picture they paint is not encouraging.

Metals and their compounds are indispensable to our way of life and have been key factors in advancing modern civilization's fight against hunger and disease. Few, if any, of the metals known to mankind have not found some application, and the number of commercial uses continues to grow as science and technology develop. Consequently, as the authors demonstrate, metals released to the biosphere from human activities have now inundated the natural biogeochemical flows of these trace elements. For example, each year 17 times as much lead enters the atmosphere from anthropogenic sources as from natural sources.

The global estimates of contamination are necessarily crude, but the authors are confident that their calculations yield totals that are of the right order of magnitude. The numbers are high. The mobilization of arsenic into the biosphere as a result of human activity is estimated to be 120 000 tonnes per year; of cadmium, 30 000 tonnes per year; and of lead, 1 160 000 tonnes per year. The toxic properties of these metals are well known, and their greatly increased circulation through the soils, water and air is a cause for concern.

INTERNATIONAL TRACE METALS CONFERENCE

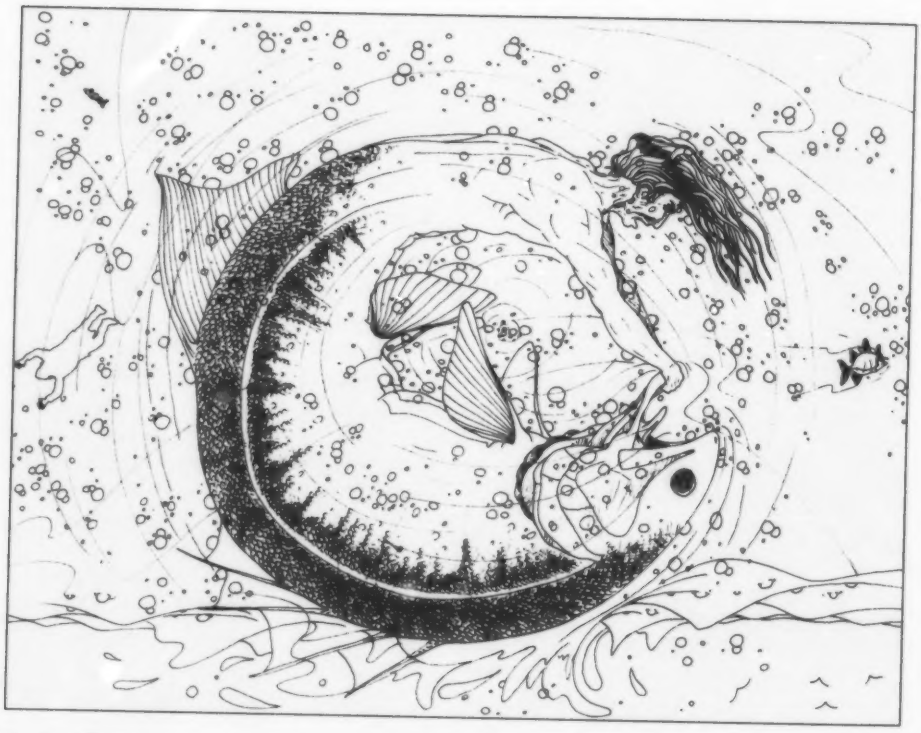
Pollution by trace metals has been recognized as a serious and growing environmental threat for many years, but much remains to be understood about their global magnitude and ecological impacts. To help strengthen and focus scientific attention, two NWRI scientists, Drs. J.O. Nriagu and K.R. Lum, organized the first International Conference specifically on Trace Metals in Lakes.

The Conference, held at McMaster University in Hamilton from August 14 to 18, 1988, drew over 150 experts from 20 countries. It was sponsored by Environment Canada, the Ontario Ministry of Environment, the U.S. EPA, McMaster University, the Canada/U.S. International Joint Commission, the Chemical Institute of Canada, and the Conservation Foundation, Washington. The sessions covered a broad range of trace metal issues in lakes, including historical loading trends, the ecotoxicology of metal mixtures, and acid rain effects on the mobilization of metals.

The meeting not only drew attention to the worldwide extent of lake contamination by toxic metals but highlighted the fact that most freshwater research laboratories are ill-equipped to measure accurately the low levels of metals typically found in lake ecosystems.

About a decade ago, marine scientists using specially designed "clean laboratories" were able to demonstrate a close linkage between nutrient and trace metal cycles in sea water. This research led to a major revolution in the understanding of the marine cycle of toxic metals. Only a few "clean laboratory" data for lakes were presented at this conference, but they point to similar relationships existing in freshwater. It is thus likely that current wisdom on the behaviour of metal pollutants in lakes will soon be revised.

Following the conference, NWRI began construction of a new "clean laboratory" for metal analysis. Thirty-five papers selected from those presented at the conference will be published in a special 1989 issue of *Science of the Total Environment* .



Endless Quest

Man's endless quest
To discover and control
His own destiny
Is like a lost child
In a torrent river

The truth of destiny
Is the river itself

GLOBAL LAKE CONSERVATION AND MANAGEMENT

In the early 1980s, Dr. M.K. Tolba, Executive Director of the United Nations Environment Programme (UNEP), proposed that regularly scheduled international conferences on lake conservation and management be held near lakes for which intensive and successful protection measures have been taken. The first two of these conferences were held at Lake Biwa, Otsu, Japan, and on the Great Lakes at Mackinac Island in the United States. The conferences are held every two years under the auspices of the International Lake Environment Committee (ILEC) Foundation based in Japan.

The third in this series of conferences took place in September 1988, at Keszthely, Hungary, on the shore of Lake Balaton. Some 230 participants from 31 countries and four continents attended the conference. At the request of the organizers, Drs. R.A. Vollenweider and R.J. Allan of NWRI delivered two of the seven invited plenary speeches. Dr. Vollenweider reviewed the progress made in understanding and controlling eutrophication, while Dr. Allan provided a global assessment of the extent and trends in toxic chemical contamination in major lakes. Along with three other NWRI papers, the plenary lectures demonstrated the high degree of integration of applied research and water management in Canada.

In a related initiative, NWRI is collaborating with ILEC and UNEP in a joint survey of the state of lakes throughout the world. Basic descriptive data as well as information on water quality concerns will be compiled and published for several hundred large lakes. NWRI is coordinating the Canadian contribution to this project through a contract to Brock University. Forty-one major Canadian lakes have been chosen, both from different physiographic regions of Canada and from relatively pristine and relatively polluted systems. Generous cooperation has been received from provinces, universities and other federal government agencies. When this project is complete, the information will be valuable in both a Canadian and global context for comparing lake conditions in different settings and for tracking the degree of pollution in lakes.

RESEARCH NEEDED FOR GREAT LAKES CLEANUP

The Canada-U.S. International Joint Commission has identified 42 Areas of Concern in the Great Lakes Basin. These locations are considered to be the most seriously polluted areas in the basin and were singled out for attention on the basis of a variety of water quality criteria. Canada and the United States have agreed to prepare Remedial Action Plans (RAPs) for each of these areas. RAPs will not only identify specific measures to control sources of pollution, clean up contaminated environments, and restore appropriate uses but will also present schedules for the implementation of specific remedial actions.

The effort to develop remedial action plans has uncovered a host of unanswered questions that need to be addressed quickly by the research community so that cleanup can proceed. Can contaminated bottom sediments be capped or covered up, or do they have to be removed by dredging, which is both environmentally disruptive and expensive? How can we immobilize or destroy toxic components in treatment plant sludges? Are fish populations limited by habitat or by food in Areas of Concern?

The International Joint Commission, through its Council of Great Lakes Research Managers, prepared a synopsis of these research needs to help focus the attention of the Great Lakes research community on the RAPs. This synopsis, which was published and given wide distribution by the Commission, was compiled and co-edited by Mr. C.B. Gray from NWRI. Remedial Action Plan coordinators and scientists throughout the basin contributed to this effort. It is clear from this report that the research capability in the Great Lakes Basin will be hard pressed to provide answers to the many RAP-related questions. More important than ever before is the dialogue between the research community and those charged with the responsibility to prepare the Remedial Action Plans.

GREAT LAKES TOXIC CHEMICALS: CAUSE AND EFFECT

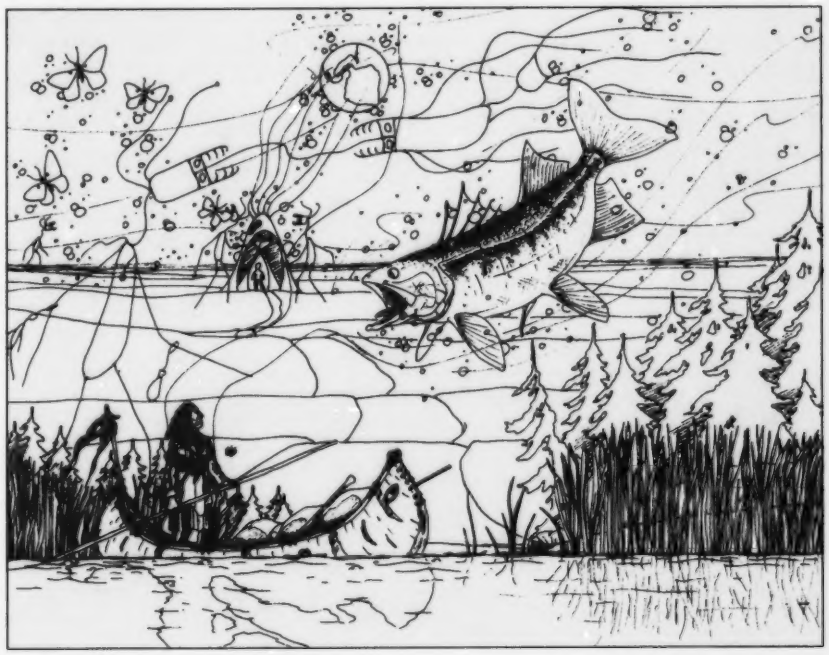
Have scientists been able to demonstrate, to the satisfaction of accepted scientific standards, that toxic chemicals in the Great Lakes ecosystem have caused disease in the fish, wildlife, and human residents of the basin? This was the important question addressed by 70 experts invited to a workshop organized by the International Joint Commission's Council of Great Lakes Research Managers in March of 1989. Mr D.L. Egar of NWRI is the Canadian Co-Chairman of the Council.

Case studies on several species of fish, birds, snapping turtles, mink, otter and human beings were presented by specialists who study these animals. A unique feature of the workshop required each speaker to present evidence in support of his or her hypothesis in a common, specified format so that the audience could judge the strength of the case in light of accepted epidemiological criteria for demonstrating cause and effect. This proved to be most useful. It revealed data gaps, weaknesses in experimental design, and allowed comparison between cases. It was agreed that the cases discussed were the best, and virtually the only, studies of this sort available for the Great Lakes. This is regrettable, given the importance of this aspect of the toxic chemical issue for future management of contaminants.

The central question of the workshop proved difficult to answer. Were the cases scientifically compelling? The complexity of the answer was apparent at the outset when Dr. W. Swain pointed out that epidemiology itself is, at best, an inexact science. Many speakers described seemingly insurmountable obstacles standing in the way of a rigorous demonstration of cause and effect.

Dr. I. Nisbet, in summing up the workshop, compared the problem to the layers of an onion. Taken all together, considering the many similar effects in different species in different geographical areas, all correlating to some degree with the presence of toxic chemicals, it is difficult not to believe that there is some connection. However, peeling away the layers of the onion and considering the cases individually, doubts begin to appear. Finally, at the layer of greatest complexity, where specific cause-effect mechanisms are being sought, it is clear that linkages have yet to be demonstrated. There was thus a strong consensus that more epidemiological and ecological research is needed in this area.

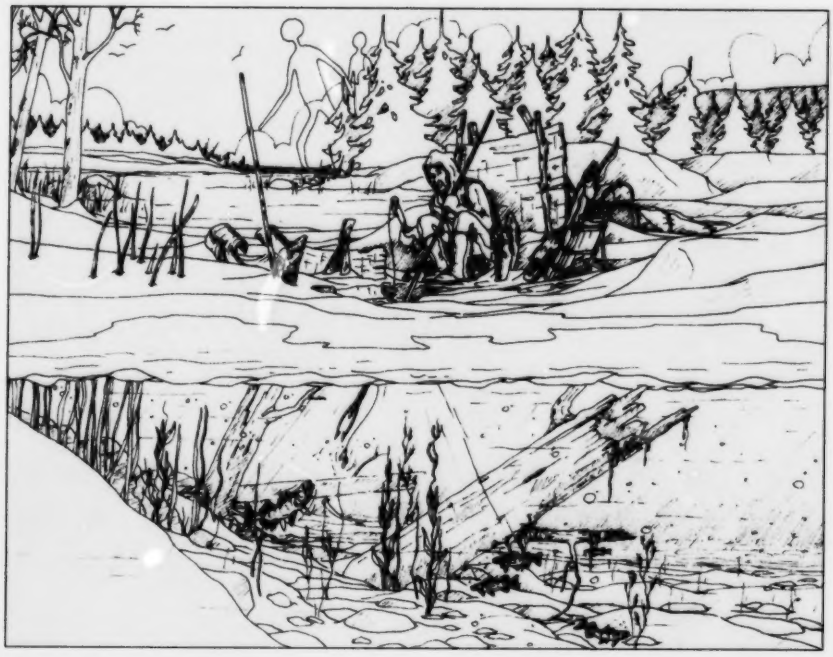
Action to control toxic chemical pollution in the Great Lakes has not, of course, waited for rigorous proof of cause and effect. Policy-makers have acted with prudence in response to the demonstrated risk of harm from such contaminants. Many speakers at the workshop presented data showing sharp declines over the last decade in the levels of toxic chemicals found in various components of the Great Lakes ecosystem. This is encouraging evidence that past policies of prudence are working.



Dream and reality

Environmental connections

"Twenty years ago the problem was eutrophication and we were trying to understand how nutrients affected lakes. Then we got worried about toxic chemicals and tried to understand how they behaved in the aquatic ecosystem. Now we've shown that these two problems are connected and it has led to a whole range of important new ideas." Dr. J.H. Carey is explaining the rationale behind NWRI's Nutrient-Contaminant Interactions Project.



Eternal Bond

Eutrophication – the process by which lakes become overenriched, produce unwanted algae and suffer from oxygen depletion – and contamination of lakes have traditionally been considered independently by scientists and water managers alike. Contaminant research has largely focused on environmental pathways and effects of specific chemicals, whereas eutrophication research has concentrated on the relationship between nutrient inputs and biological productivity. Although the management of both issues is often based on setting "objectives," nutrient objectives seldom consider the presence of persistent contaminants, while contaminant objectives rarely, if ever, consider the trophic state of the system.

HIGHLIGHTS

The Nutrient-Contaminant Interactions Project is based on the premise that contaminant dynamics and effects in aquatic systems are likely to be directly influenced by the trophic state of the system and, therefore, the eutrophication and contaminant issues cannot be considered separately.

Dr. Carey and his collaborators have been studying a set of headwater lakes at a field site near Bancroft, Ontario. As these lakes are in an area of transition between igneous and sedimentary bedrock, a selection of lakes with differing chemical composition is available for study. Most of the lakes have a single major source of contamination – the atmosphere. The research program examines the general hypothesis that nutrients interact with contaminants by influencing four processes: bioaccumulation, degradation, sedimentation and transport. Thus, the objective of the project is to identify the key variables that can be used to describe and predict these contaminant processes and apply the findings to Great Lakes issues.

The results to date have been exciting. Zooplankton (microscopic animals important in the aquatic food chain) from more than 30 lakes were analyzed for contaminants. An inverse relationship was discoverd between springtime total phosphorus concentrations in the lake water, which is generally proportional to the extent of eutrophication, and the concentration of various toxic chemicals in the zooplankton. Thus, the premise that trophic status and contaminant dynamics are coupled appears to be correct. Even more interesting, the rate of contaminant degradation has been shown to be greater in more productive lakes. These findings have spawned a range of new, promising lines of research and have generated increased interest within the research community. Currently, scientists from eight universities are collaborating on this research.

Environmental scientists gather in Quebec

An International Symposium on the Fate and Effects of Toxic Chemicals in Large Rivers and their Estuaries took place in Quebec City in October 1988. This conference proved to be an important event, combining environmental research issues and public concern over the health of our large rivers, particularly the St. Lawrence. The conference was organized by Dr. R.J. Allan, NWRI, and Dr. P.G.C. Campbell, INRS-Eau (Institut national de la recherche scientifique – Eau), Quebec. Over 100 scientific leaders from 20 countries presented recent research results and overviews of river pollution issues in different parts of the world. Media coverage of the event was extensive.

The Canadian focus at the conference was on the St. Lawrence system. The Honourable Lucien Bouchard opened the conference on behalf of the Government of Canada and, in his remarks, drew attention to the pollution problems in the St. Lawrence and to the cleanup actions planned by the federal and provincial governments. He acknowledged the need for research and challenged the assembled scientists to concentrate their efforts on attacking these problems. Altogether 27 papers concerning the St. Lawrence were presented at the symposium, one third of which were given by NWRI scientists. The conference provided an ideal forum for researchers working on the St. Lawrence to compare their results and to engage in dialogue with leading scientists working on similar problems in other countries. The St. Lawrence papers will be published together as a special issue of the *Water Pollution Research Journal of Canada*.

An important underlying theme of the discussions concerned the unique difficulties encountered in trying to investigate and understand the large river/estuary environment, which many believe to be the most complex aquatic ecosystem in the world. Examples from other countries revealed the need to design interdisciplinary studies that permit both freshwater and marine scientists to collaborate and create a pool of expertise adequate to the challenge.

PULP MILL STUDIES

Dioxin has been found in the aquatic environment near pulp mill outfalls in British Columbia. This has triggered nationwide interest in investigating the impact of pulp mill effluents on the environment. NWRI scientists are engaged in a range of studies as part of a larger government effort to address this concern.

In one study, Dr. J.H. Carey and Dr. R.M. Baxter are determining whether natural environmental processes in coastal systems are transforming less toxic forms of dioxin attached to wood fibres into the 2,3,7,8-TCDD variety, thought to be the most toxic form of dioxin there is. So far they have shown that the conditions are right for this reaction to take place and they have observed its occurrence with other chemicals, but not with dioxin.

Dr. Carey is also analyzing water samples from across Canada to find out whether they contain chloroguaiacols and phenols. The samples have been taken near pulp mill outfalls. Previous NWRI studies suggest that these chemicals might be present in large quantities in some mill effluents. In a related investigation, Dr. H.B. Lee is doing a broad-scale analysis on selected mill effluents to determine the complete range of chemicals present.

An in-depth study of one pulp mill and its effect on the aquatic environment is planned for the coming year. The Canadian International Paper mill at La Tuque has been selected for this study and cooperation arranged with scientists from Environnement Québec and Environment Canada's new science centre in Quebec, Centre Saint-Laurent. Water, sediment and biota samples will be taken and analyzed, and the research focus will be on the transport and bioaccumulation of dioxin. Several other associated studies are also in the planning stages. When considered all together, the results of this work will be invaluable to the formal assessment of the toxicity of pulp mill bleachery effluents required under the new Canadian Environmental Protection Act.

ENCOUNTER

GROUND WATER CLEANUP TAKES MONEY AND KNOW-HOW

About one quarter of Canada's population draws its water supply from underground reservoirs known as aquifers. These are deposits of sands and gravels or fractured rock filled with water. Some of these aquifers have become contaminated with chemicals from hazardous waste sites or from spills.

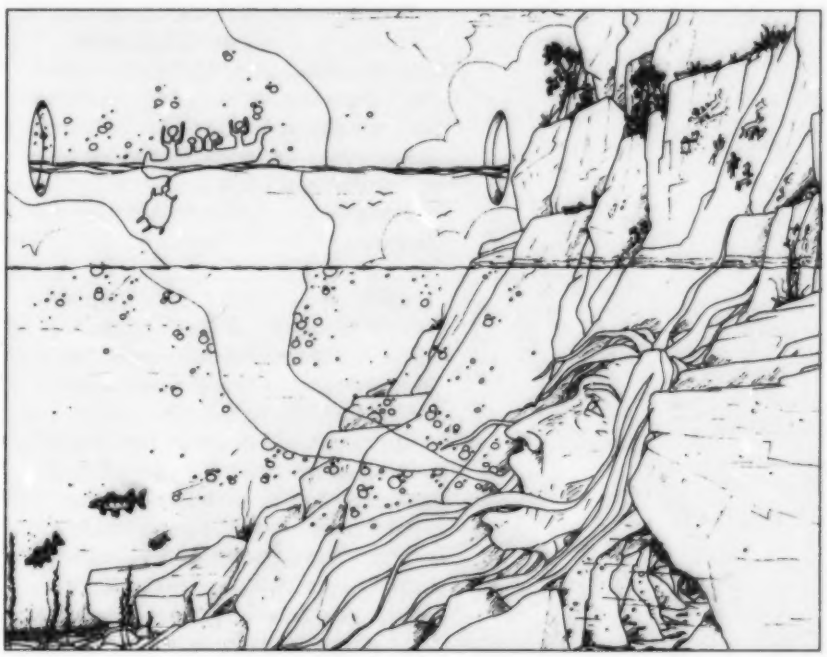
Over the last decade there has been a major effort in the United States, through their Superfund Program and corporate initiatives, to restore polluted aquifers. Despite expenditures of over $30 million per month, little progress toward decontamination has been made due to the technical difficulties involved. Similar efforts began in earnest in Canada in 1984 at Mercier, Quebec. Several projects are now planned for the 1990s, with price tags ranging from about six million dollars at the Gloucester Landfill near Ottawa to an estimated $100 million required to decontaminate the bedrock aquifer beneath Smithville, Ontario, which is contaminated by PCBs.

Aquifer restoration may involve one or more technical operations to remove both the source of the contamination and the chemical plume which invariably migrates underground away from the source. Often, the first step is to excavate the source itself. For example, at the Gloucester Landfill, Transport Canada hired engineers to remove drums of solid waste together with highly contaminated soil from the federal government's Special Waste Compound. The second step normally is to install a "pump and treat" system, whereby contaminated ground water is pumped to the surface and decontaminated in a wastewater treatment plant, then recharged back to the aquifer. NWRI scientists are developing an optimized purge and recharge well network for the Gloucester aquifer using several computer models in tandem. This is the first time work of this nature has been undertaken in Canada.

Pump and treat systems work well, provided that the contaminants do not stick to the grains of the aquifer material and that no blobs of chemicals exist as separate phases within the aquifer. When this does occur, pump and treat operations fail to decontaminate the system and merely prevent further spread of the chemicals in the ground water. This explains why many of the Superfund restoration projects have run into difficulties.

Accordingly, research efforts are now turning to *in situ* decontamination processes such as:
(1) enhanced biorestoration, in which oxygen and nutrients are added to the contaminated aquifer to assist native bacteria in degrading the contaminants;
(2) chemical decontamination using surfactants;
(3) steam injection, which has recently been used successfully in California to recover organic solvents from an aquifer.

Needless to say, even to evaluate these approaches at the pilot plant scale is very costly. NWRI scientists are working with private consultants and engineers from Environment Canada's Wastewater Technology Centre to assess aquifer restoration techniques at hazardous waste sites in Ontario, Quebec and Nova Scotia. What has become evident from this experience is that investment in an appropriate hydrogeological and chemical investigation of the site at the outset is essential to avoid the application of costly but ineffectual decontamination technologies.



SACRED PLACES

New laboratory association launched

"Environmental analytical laboratories have a bright future in Canada. With the new legislation for regulating and cleaning up toxic chemicals, the demand for chemical analysis and biological testing is soaring. But the laboratories have got to get their act together to ensure that their customers can trust the quality of their analyses." Dr. J. Lawrence should know. As Director of NWRI's Research and Applications Branch, he runs one of Canada's most respected laboratory quality assurance programs. He also spent the last year convincing leaders in the Canadian environmental laboratory industry that they they should form an association to protect the future of the industry. Not that they took much convincing.

"Quality really is Job 1 in the laboratory industry," says Dr. P.G. Sly of the Rawson Academy of Aquatic Science. "If the results aren't credible, they are worthless." The Rawson Academy worked with NWRI under contract to investigate the feasibility of setting up a new laboratory association. The concept met with widespread support from all sectors of the industry (private sector, university and government). All concerned recognize the need for high standards of quality assurance and control. There was broad support for an independent, self-regulating association of environmental laboratories to prepare the industry for the increased analytical workload arising from the Canadian Environmental Protection Act and other priority environmental programs.

In January 1989, the interim Board of Directors of the new Canadian Association of Environmental Analytical Laboratories held its first meeting. Bylaws have been drafted and steps taken to have the Association formally incorporated. Preliminary discussions have been held with representatives of the Standards Council of Canada, who were very receptive to the idea of developing an accreditation program for member laboratories. Information meetings have been held in the Atlantic Provinces, Quebec, Ontario, the Prairie Provinces, and British Columbia and interest in membership was strong across the country.

All indications are that the Association is off to a good start. This is encouraging, as Canada will need a strong national network of credible analytical laboratories to support the important environmental initiatives on which our future depends.

Oil and water

The continuing demand for fossil fuels and the limited global reserves of conventional crude oil have increased interest in heavy oil development. It has been estimated that 40% of the world's oil and 90% of Canada's oil supply is contained in heavy oil deposits. Most of Canada's reserves are located in Alberta's oil sands.

The Athabasca oil sands deposit in northeastern Alberta is one of the world's largest known hydrocarbon reserves. Current estimates suggest that this deposit contains the equivalent of 26 billion barrels of synthetic crude oil recoverable with current technology. This represents over four times Alberta's current proven reserves of conventional crude oil.

The hydrocarbon potential of this region may lead to rapidly accelerating industrial development. If this appears likely, concern will be raised over the environmental impact of such development, especially should there be an accidental release of raw materials to the environment. A series of equipment failures did occur at the Suncor oil sands and bitumen upgrading plant on the Athabasca River in 1982. More than 50 tons of oil was released to the river over several weeks. During the subsequent investigation, it became apparent that very little of environmental significance was known about the types of chemical compounds present in heavy oil and partially upgraded heavy oil. Initial research revealed that the spilled material contained numerous water-soluble components of environmental concern. It also revealed that appropriate analytical methods for the isolation and identification of toxic chemicals in complex samples of heavy oil were generally not available. These methods and an understanding of how these chemicals behave in a northern aquatic environment will be indispensable in predicting the impact of future spills and discharges.

Dr. E.D. Ongley of NWRI has recently acquired funding from Canada's Panel on Energy Research and Development to study the fate and effects of chemicals from tar sands plants on the Athabasca River. This study has attracted interest from a wide range of environmental and resource management agencies, and it promises to grow into a multifaceted project with important implications for future development in the region.

But few will see me

The earth never offered man

Water

As a gift

Water was part of her

It is her blood

Her moving life force

And in this, she said,

You will see your greed

Your mistakes

Your image

But few will see me

SCIENCE AND CEPA

The Canadian Environmental Protection Act (CEPA) was given royal assent in June 1988. This landmark legislation not only represents an important step toward environmental security for Canada but also sets forth a very ambitious regulatory agenda.

In January 1989, Environment Minister Lucien Bouchard approved the Priority Substances List, one of the regulatory instruments called for in the Act. This list comprises 44 substances, each of which must undergo a formal assessment within five years to determine whether it should be regulated under the Act. These assessments will require an enormous amount of work to complete within the prescribed time frame.

What demands will be made upon Canadian scientists, and can they be persuaded to accomplish the desired results? These were the questions facing 100 representatives from public interest groups, universities, industries and governments who participated in the CEPA Priority Substances Science Forum hosted by NWRI in February 1989.

As might be expected, a variety of viewpoints were expressed. Most participants agreed that Canada possesses the scientific capability needed to support the assessments, but expressed the reservation that this capability is widely dispersed and could not easily be focused on CEPA priorities. There was also general agreement that Canadian researchers should concentrate their efforts on work that can only be done in Canada, such as investigating the behaviour and effects of priority substances in Canadian ecosystems. As much as possible, research from other countries should be relied upon for more generic information on the toxicity of specific substances.

Finally, the forum participants identified the two main hurdles that must be overcome if we are to marshal sufficient scientific support for the CEPA assessments. First, we need to prepare, for each priority substance, an outline of the specific research necessary to decide whether the substance should be judged toxic and regulated under CEPA. Second, we need to create a coordinating and brokering mechanism to ensure that the scientific capability available to us is used to best advantage. These are not minor challenges, but the forum demonstrated that there exists a concerned community of scientists and decision-makers committed to the success of this initiative and to the protection of Canada's environment.This alone is sufficient reason to be optimistic.

BIOLOGY AND ENVIRONMENTAL REGULATION

How should we regulate polluters? How can we express the limits we set on what they are allowed to put into our lakes and rivers? How can we make sure that what they are discharging in their effluents is not causing any harm? In the past, we have relied mainly on limiting the amount of specific chemicals that can be discharged, and then monitoring the effluents and the water for those chemicals. We have learned the hard way that this is not always sufficient. We can never be sure that all toxic chemicals in the effluent are being measured or that low, persistent concentrations of such chemicals are not causing problems.

Seventy-five experts and decision-makers recently recommended that "Biological testing and monitoring must be integrated with chemistry in a multi-disciplinary manner when applied in hazard assessment and regulatory control." They made that recommendation at a workshop entitled "Biology in the New Regulatory Framework for Environmental Protection," which was co-organized by NWRI. They believe that observing how living organisms such as fish or algae are affected by exposure to contaminants in the environment is a very powerful way to help decide whether too much pollution is present.

Participants at the workshop represented a wide range of interests and viewpoints. They came from federal, provincial and municipal agencies, from industries, from universities, and from private sector consulting firms. Invited speakers provided an overview of biological toxicity methods used in Canada as they relate to the Canadian Environmental Protection Act, the Pest Control Products Act, and Ontario's Municipal Industrial Strategy for Abatement program. This legislation signals a greater emphasis on environmental regulation, an emphasis which is already apparent to those being regulated. Industry representatives and private consultants were invited to discuss the benefits, problems and economic opportunities generated by this legislation. There were vigorous debates and consensus emerged on seven principal recommendations from the workshop.

The first recommendation states that "the federal government (should) develop a national framework for biological toxicity tests and make the policy decisions required to set biology-based regulatory standards in place. In addition, the federal government should expedite the development of standardized protocols for biological toxicity tests." Environment Canada is acting on this recommendation. A policy and program framework for biological testing is in preparation, and three biological test methods have been written and will be released for public review in the near future. Other recommendations concerning governmental roles in research, monitoring and quality assurance are also being implemented.

COMINGS AND GOINGS

During the year NWRI was honoured by visits from an unprecedented number of eminent and influential people. Canada's Prime Minister, the Right Honourable Brian Mulroney, and his wife Mila toured the Institute's Hydraulics Laboratory on October 19. Shortly thereafter Mr. Mulroney announced a new 125 million dollar plan to address pollution problems in the Great Lakes. Earlier in the year, Her Majesty Queen Beatrix and His Royal Highness Prince Claus of the Netherlands visited NWRI. Dr. R.J. Allan briefed them on the research conducted at the Institute, emphasizing the scientific collaboration between Canada and the Netherlands.

Dr. C.G. Forsberg, Professor of Limnology and Director of the Institute of Limnology, University of Uppsala, Sweden, spent a week at NWRI in June. Dr. Forsberg was the first recipient of the annual NWRI Vollenweider Lectureship in Aquatic Sciences, awarded to scientists eminent in fields of research important to NWRI. His lecture entitled "Limnological Research and Water Management" was well received by Institute staff and guest scientists.

During the year, many scientific delegations visited the Institute. As part of a Canada-Japan Prime Ministerial Task Force, a group of Japanese water management experts explored potential opportunities for collaboration during a visit organized by the Science Council of Canada. Several national delegations attending the World Conference on the Changing Atmosphere in Toronto subsequently visited the Institute to discuss research needed to assess the impacts of climate change on water resources. Scientists from the People's Republic of China discussed toxic chemical pollution, acid rain and research

cooperation during three official visits. In addition, NWRI welcomed water experts from the Netherlands, Norway, New Zealand, France, West Germany, and Guatemala.

The expertise of NWRI's senior scientific staff is highly regarded throughout the world. Dr. J. Barica was named to the Canadian delegation attending an urgently convened scientific symposium in Bonn, West Germany, on the death of seals and growth of algae in the North Sea and Baltic Sea. The meeting of experts was organized by the German Federal Minister of the Environment to identify causes for the recent ecological disaster.

Dr. E.D. Ongley is a Vice-President of the International Commission on Continental Erosion. He attended a meeting of the Commission in Brazil, which focused on global environmental issues, notably deforestation and its consequent ecological and physical damage.

The International Hydrology Programme (IHP) of UNESCO hosted an international workshop in Thailand on the impact of metals from mining operations on tropical environments. IHP UNESCO invited Dr. R.J. Allan to attend the workshop as one of three western experts.

Dr. R.J. Daley represented Environment Canada at an Experts Meeting on Environmental Monitoring in Switzerland, which assessed global levels and trends in urban air quality, food contamination and water pollution. As a result of the meeting, a comprehensive review of the World Health Organization's Global Environmental Monitoring Program on Water (GEMS-WATER) will be held at NWRI.

These are examples of the numerous opportunities for influence that result from the international respect earned by NWRI scientists.

Spring Journey

ENVIRONMENTAL PEACEKEEPING

"It's a terrible Canadian cliche but it's true, we are credible in the Third World, we are credible in the French-speaking world, we have got a lead in this area (sustainable development) because of Brundtland and the related domestic activities I've outlined, but it's a leadership role that has to be grasped and played. It won't be done by just being one of the fellow travelers." Dr. D. Runnalls of the Institute for Research on Public Policy made this eloquent plea for Canadian leadership at a symposium on sustainable development hosted by NWRI.

The litany of global environmental threats is, by now, familiar. The earth's protective ozone layer is being chemically eroded, most dramatically over the Antarctic where a giant ozone hole appears every spring. This has worldwide implications for increases in cataracts and skin cancer. The greenhouse effect is expected to result in an increase in average temperature at the equator of 1.5 to 4.5 degrees Celsius over the next 50 years. Agriculture, forestry, fishing and tourism will be affected everywhere. Sea levels may rise, flooding coastal areas where hundreds of millions of people live. The island nation of the Maldives may disappear from the face of the earth.

Now, in the span of one year, six million hectares of land is degraded to desert-like conditions and 11 million hectares of tropical forests is destroyed. This devastation leads ultimately to starvation and the migration of "environmental refugees." Today, the winds and rain carry toxic chemicals across international boundaries and even wilderness environments are contaminated. Ships

dump toxic wastes at sea or in unsuspecting countries. Nigeria has discovered toxic waste sites it never knew it had, and in the United States, medical waste washes ashore on some beaches.

After describing these international environmental problems, Environment Canada's Assistant Deputy Minister for Policy, Dr. R.W. Slater, concluded: "For the first time in history, human activities are undermining the stability of the ecosystem on a global scale – and they are doing so to a degree that is life-threatening to some species, not the least of which is our own." What is most significant is that he made these remarks in a speech he presented to Canada's National Defence College. It reflects the realization that, in the face of these global environmental threats, the concept of national security takes on a new meaning.

"Environmental Peacekeepers: Science, Technology, and Sustainable Development in Canada" is the title of a report released last year by the Science Council of Canada. It sets forth the role for science and technology in realizing the potential of sustainable development and thereby reconciling Canada's environmental and economic imperatives. The title also evokes associations with international reconciliation, suggesting that there might be a role for science in diffusing the environmental and economic tensions between the developed and developing worlds. At the NWRI symposium Dr. Runnalls and others called for what amounted to a global Sustainable Development Initiative which would be a strategic investment in national security. It is still unclear how environmental science can contribute best to the achievement of sustainable development goals and NWRI is currently addressing this question.

A NEW PROMISE

PAPER IN THIS PUBLICATION CONTAINS RECYCLED FIBRES
AND IS UNCOATED TO FACILITATE RECYCLING.

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